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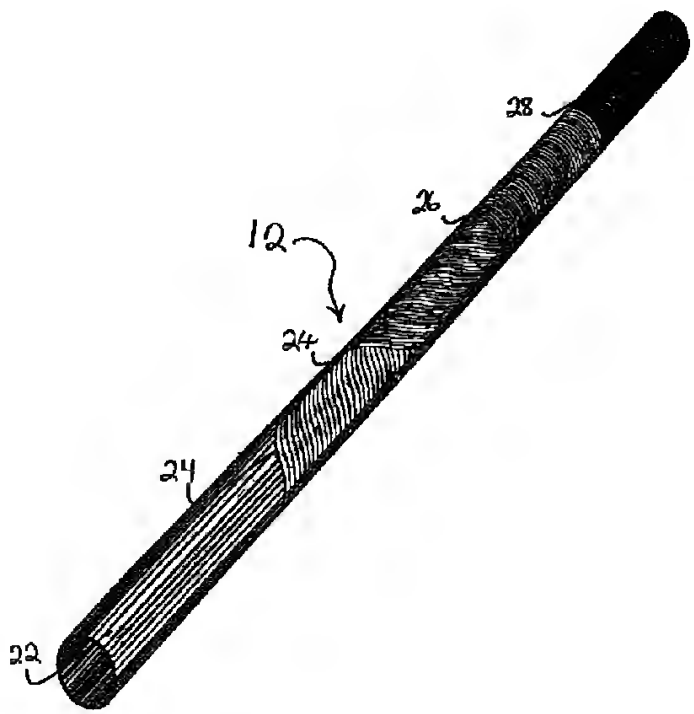
(54) Titre : METHODE DE FABRICATION DE PIECES COMPOSITES TUBULAIRES EN MATERIAU COMPOSITE PAR ENROULEMENT FILAMENTAIRE

(54) Title: METHOD OF MANUFACTURING COMPOSITE TUBULAR PARTS THROUGH FILAMENT WINDING



(57) Abrégé/Abstract:
A method of manufacturing composite tubular parts through a filament winding process, comprising the following described steps. A first step involves providing an elongate mould having a relatively even outer surface. A second step involves winding dry filament upon the mould in a desired orientation. A third step involves enclosing the mould in e vacuum chamber end infusing resin into the dry filament wound upon the mould by vacuum infusion. A fourth step involves permitting the resin to set to form a tubular part and removing the tubular part, so formed, from the mould.

ABSTRACT OF THE DISCLOSURE

A method of manufacturing composite tubular parts through a filament winding process, comprising the following described steps. A first step involves providing an elongate mould having a relatively even outer surface. A second step involves winding dry filament upon the mould in a desired orientation. A third step involves enclosing the mould in a vacuum chamber and infusing resin into the dry filament wound upon the mould by vacuum infusion. A fourth step involves permitting the resin to set to form a tubular part and removing the tubular part, so formed, from the mould.

TITLE OF THE INVENTION:

Method of Manufacturing Composite Tubular Parts Through Filament Winding

FIELD OF THE INVENTION

The present invention relates to a method of manufacturing composite tubular parts, such as power poles, through filament winding.

BACKGROUND OF THE INVENTION

Filament winding is a process in which wet resin is applied to filaments and the filaments are wound onto a tubular mould. The resin sets to bind the filaments together, thereby forming a tubular body around the tubular mould. The tubular body is then removed from the mould. This process is used for the manufacture of various tubular structures, such as power poles.

There are a wide variety of fibers that are suitable filaments for use in this process, such as glass, carbon and aramid. There are, similarly, a wide variety of resins that are suitable for use in this process, such as polyester, epoxy, vinyl ester, phenolic. The fiber and resin selected depends upon the end characteristics required for the tubular structure.

The strength of the tubular structure produced by the process is, in part, dependent upon the orientation of the filaments. There are, however, practical limitations inherent in the current process. If the angle of the filaments is too severe they tend to slide off the tubular mould. This problem has some effect on helical and hoop winding, but is an especially severe limitation on longitudinal windings.

SUMMARY OF THE INVENTION

What is required is an alternative method of

manufacturing composite tubular parts through a filament winding process that does not have the aforementioned limitations on filament orientation.

According to the present invention there is provided a method of manufacturing composite tubular parts through a filament winding process, comprising the following described steps. A first step involves providing an elongate mould having a relatively even outer surface. A second step involves winding dry filament upon the outer surface of the mould in a desired orientation. A third step involves enclosing the mould in a vacuum chamber and infusing resin into the dry filament wound upon the mould by vacuum infusion. A fourth step involves permitting the resin to set to form a tubular part and removing the tubular part, so formed, from the mould.

The method, as described above, does not have the same limitations as prior art processes as the filaments are wound dry, as opposed to wet with resin. This allows a longitudinal orientation of filaments. This was not possible when the filaments were wet with resin, as the filaments would tend to slide out of position. There will hereinafter be described a filament lay up sequence developed in accordance with the teachings of the present invention. It should be noted, however, that the filament lay up sequence can be changed to suit the part requirements.

BRIEF DESCRIPTION OF THE DRAWINGS

These and other features of the invention will become more apparent from the following description in which reference is made to the appended drawings, wherein:

FIGURE 1 is a perspective view of the method of manufacturing composite tubular parts through filament winding, with a first filament being orientated longitudinally on an outer surface of a mould.

FIGURE 2 is a perspective view of the method of manufacturing composite tubular parts through filament winding illustrated in **FIGURE 1**, with the mould being turned a few degrees to permit a second filament to be orientated longitudinally on the mould.

FIGURE 3 is a partially cut away perspective view of the method of manufacturing composite tubular parts through filament winding illustrated in **FIGURE 1**, showing with layers of wound filaments on the mould.

FIGURE 4 is a perspective view of the method of manufacturing composite tubular parts through filament winding illustrated in **FIGURE 1**, showing the step of vacuum infusing the filaments wound upon the mould with resin.

FIGURE 5 is a perspective view of the method of manufacturing composite tubular parts through filament winding illustrated in **FIGURE 1**, showing a completed tubular structure being removed from the mould.

DETAILED DESCRIPTION OF THE PREFERRED EMBODIMENT

The preferred method of manufacturing composite tubular parts through a filament winding process will now be described with reference to **FIGURES 1** through **5**.

Referring to **FIGURE 1**, the method includes a first step of providing an elongate mould 12 with a relatively even outer surface 40, which is free from projections. The mould is generally tubular, with a cross-sectional shape that is square, round, hexagonal or virtually any other shape. A second step is winding dry filament 14 upon outer surface 40 of mould 12. A first desired orientation of filament 14 is a substantially longitudinal orientation along mould 12 as shown for a first filament 16. Referring to **FIGURE 2**, mould 12 is rotated by at least one degree as indicated by curved arrow 18 before winding another filament 20 in substantially longitudinal orientation along mould 12. Referring to **FIGURE 3**, the above steps are repeated until at least one layer of filaments in a substantially longitudinal orientation 22 is

completed. At least one layer of filaments in a helical orientation 24 is wound on top of layer of filaments in a substantially longitudinal orientation 22. At least one layer of filaments in a hoop orientation 26 is wound on top of layer of filaments in a helical orientation 24. At least one mat 28 consisting of either chopped strand fibers or continuous strand fibers is then laid on top of layer of filaments in a hoop orientation 26.

Referring to **FIGURE 4**, in a third step, mould 12, wound with layers 22, 24, 26, and 28 described above, is enclosed in a vacuum bag 30. Vacuum bag 30 has a first end 32 and a second end 34. A vacuum or partial vacuum is created within vacuum bag 30 by withdrawing air from within vacuum bag 30 through a pump 31 at first end 32. Resin is drawn from a resin reservoir 33 at second end 34 into an evacuated space 36 between vacuum bag 30 and mould 12. The resin envelopes layers 22, 24, 26, 28 and infuses into dry filament 14 wound and laid into plurality of layers 24, 26, 28 upon mould 12 by a process known as vacuum infusion.

Referring to **FIGURE 5**, in a fourth step, the resin is permitted to set to form tubular part 10. When the resin has set, mould 12 and tubular part 10 supported thereon are removed from vacuum bag 30. Tubular part 10, so formed, is then removed from mould 12 by sliding tubular part 10 longitudinally along outer surface 40 of mould 12 as indicated by arrow 38. Tubular part 10 can then be trimmed and cut to a selected length.

It will be apparent to one skilled in the art that modifications may be made to the illustrated embodiment without departing from the spirit and scope of the invention as hereinafter defined in the Claims. In particular, the filament lay up sequence described is intended to merely illustrate the utility of the present method. It will be apparent to one skilled in the art that the filament lay up

sequence can be changed to suit the part requirements. This enables parts to be custom designs to meet particular load requirements in selected directions.

THE EMBODIMENTS OF THE INVENTION IN WHICH AN EXCLUSIVE PROPERTY OR PRIVILEGE IS CLAIMED ARE DEFINED AS FOLLOWS:

1. A method of manufacturing composite tubular parts through a filament winding process, comprising the steps of:

providing an elongate cylindrical mould having an even outer surface;

winding dry filament upon the outer surface of the mould in a desired orientation, including winding at least one layer of filaments in a substantially longitudinal orientation on the cylindrical mould accomplished by:

winding a filament in a substantially longitudinal orientation along the cylindrical mould;

rotating the cylindrical mould by at least one degree;

winding another filament in substantially longitudinal orientation along the cylindrical mould;

repeating the above steps until the at least one layer of filaments in a substantially longitudinal orientation is completed;

enclosing the cylindrical mould in a chamber and infusing resin into the dry filament wound upon the mould by infusion; and

permitting the resin to set to form a tubular part and removing the tubular part, so formed, from the mould.

2. The method as defined in Claim 1, the vacuum chamber being a bag placed around the mould.

3. The method as defined in Claim 1, the step of winding dry filament upon the cylindrical mould including winding at least one layer of filaments in a helical orientation.

4. The method as defined in Claim 1, the step of winding dry filament upon the cylindrical mould including winding at least one layer of filaments in a hoop orientation.

5. The method as defined in Claim 1, the step of winding dry filament upon the cylindrical mould including winding at least one layer of continuous strand mat.

6. The method as defined in Claim 1, the step of winding dry filament upon the cylindrical mould including winding at least one layer of chopped strand mat.

7. A method of manufacturing composite tubular parts through a filament winding process, comprising the steps of:

providing an elongate cylindrical mould having an even outer surface;

winding dry filament upon the outer surface of the mould, in a desired orientation, including

winding a filament in a substantially longitudinal orientation along the cylindrical mould;

rotating the cylindrical mould by at least one degree;

winding another filament in substantially longitudinal orientation along the cylindrical mould;

repeating the above steps until at least one layer of filaments in a substantially longitudinal orientation is completed;

enclosing the mould in a vacuum bag and infusing resin into the dry filament wound upon the mould by vacuum infusion; and

permitting the resin to set to form a tubular part and removing the tubular part, so formed, from the mould.

8. The method as defined in Claim 7, the step of winding dry filament upon the cylindrical mould including winding at least one layer of filaments in a helical orientation wound on top of the at least one layer of filaments in a substantially longitudinal orientation.

9. The method as defined in Claim 7, the step of winding dry filament upon the cylindrical mould including winding at least one layer of filaments in a hoop orientation wound on top of the at least one layer of filaments in a substantially longitudinal orientation.

10. The method as defined in Claim 7, the step of winding dry filament upon the cylindrical mould including winding at least

one mat consisting of one of chopped strand fibers and continuous strand fibers wound on top of the at least one layer of filaments in a substantially longitudinal orientation.

11. A method of manufacturing composite tubular parts through a filament winding process, comprising the steps of:

providing an elongate cylindrical mould having a relatively even outer surface;

winding dry filament upon the outer surface of the mould, in a desired orientation, including

winding a filament in a substantially longitudinal orientation along the cylindrical mould;

rotating the cylindrical mould by at least one degree;

winding another filament in substantially longitudinal orientation along the cylindrical mould;

repeating the above steps until the at least one layer of filaments in a substantially longitudinal orientation is completed;

winding at least one layer of filaments in a helical orientation on top of the at least one layer of filaments in a substantially longitudinal orientation;

winding at least one layer of filaments in a hoop orientation on top of the at least one layer of filaments in a helical orientation;

winding at least one mat consisting of one of chopped strand fibers and continuous strand fibers on top of the at least one layer of filaments in a hoop orientation;

enclosing the mould in a vacuum bag and infusing resin into the dry filament wound upon the mould by vacuum infusion; and

permitting the resin to set to form a tubular part and removing the tubular part, so formed, from the mould.

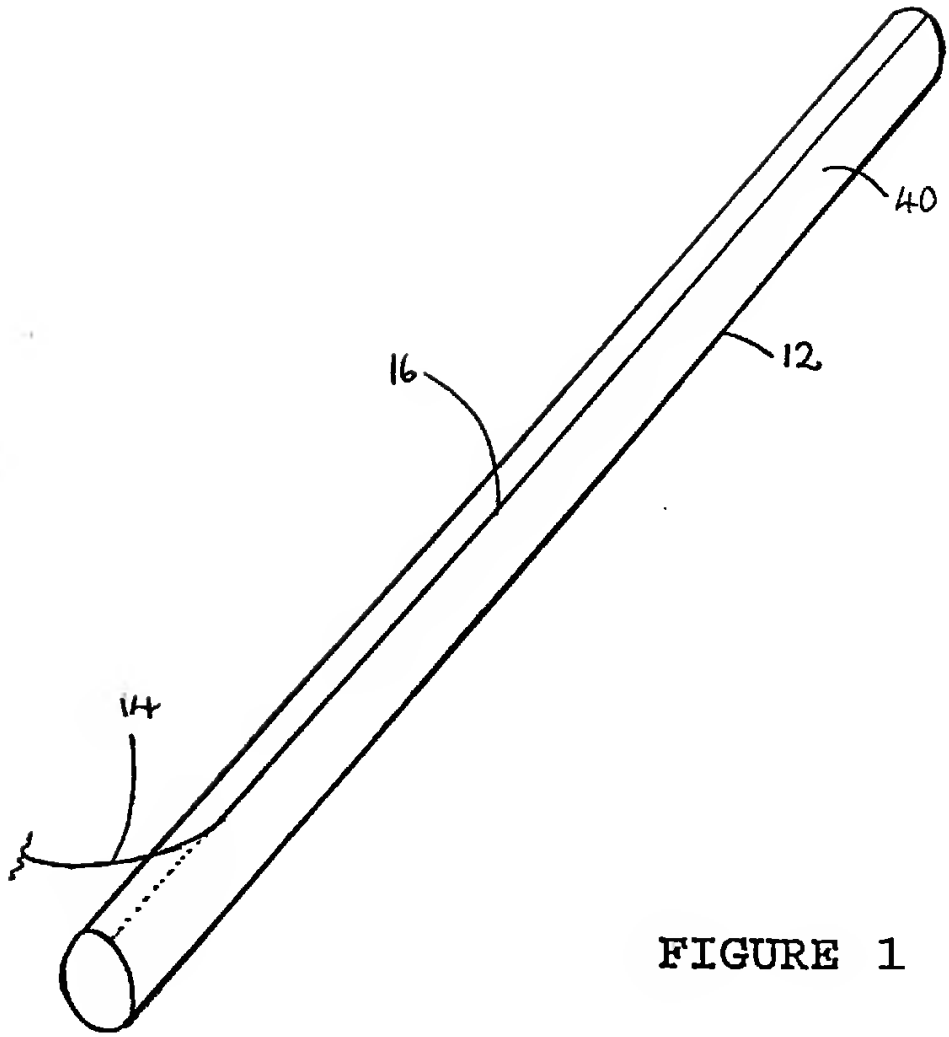


FIGURE 1

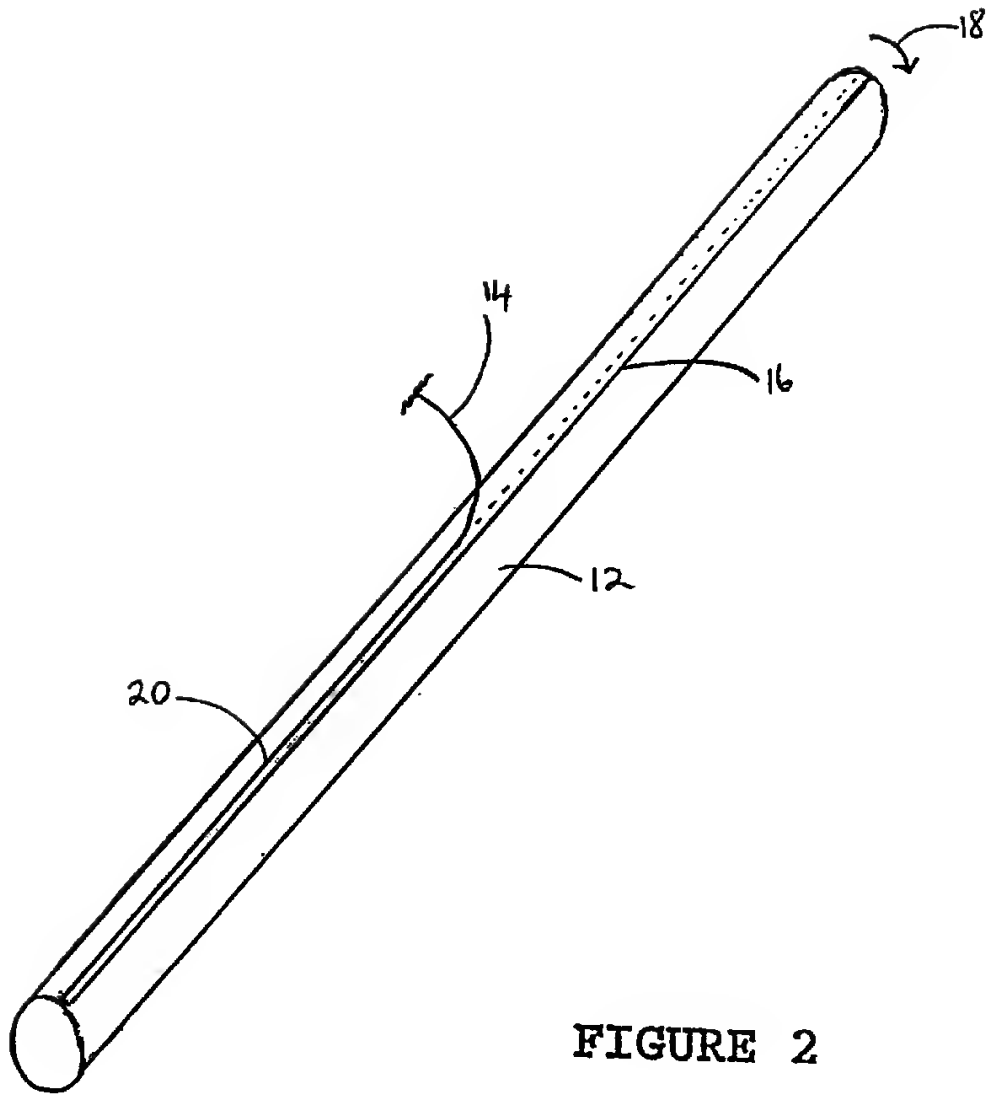


FIGURE 2

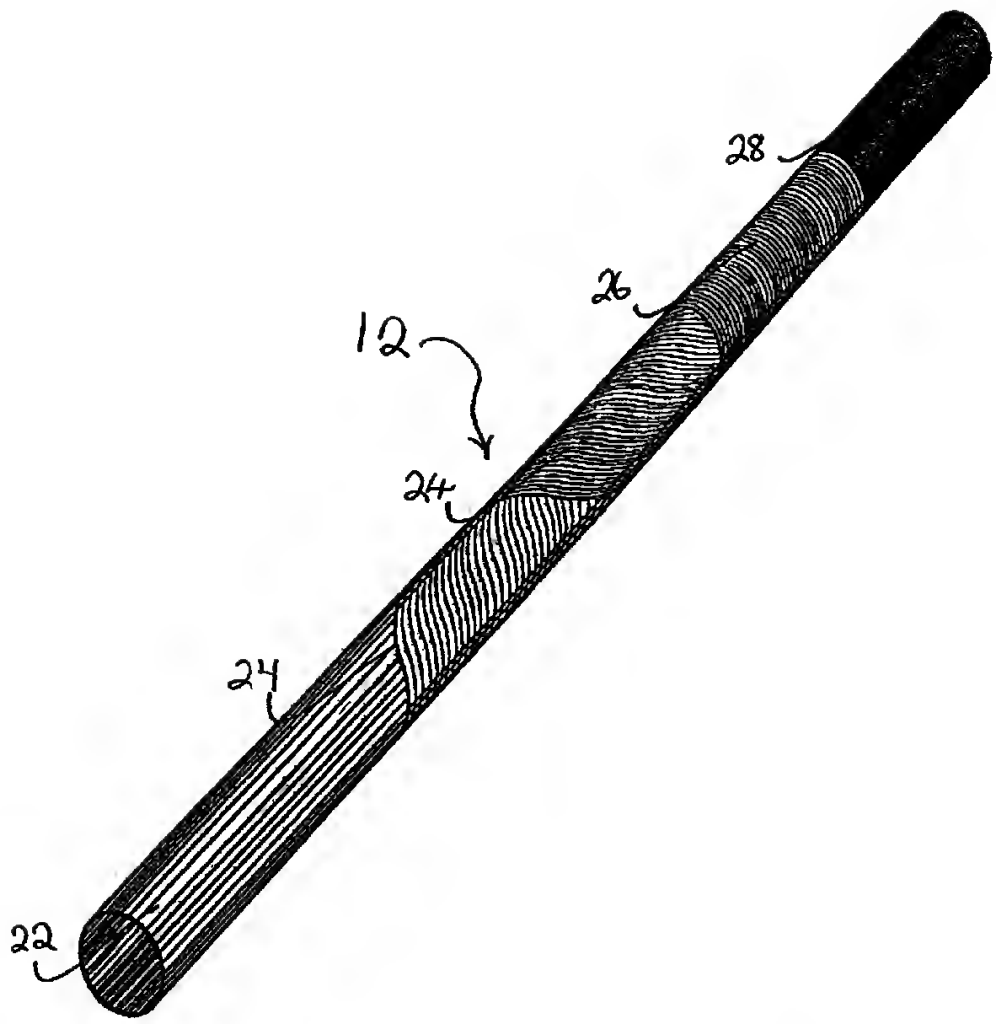


FIGURE 3

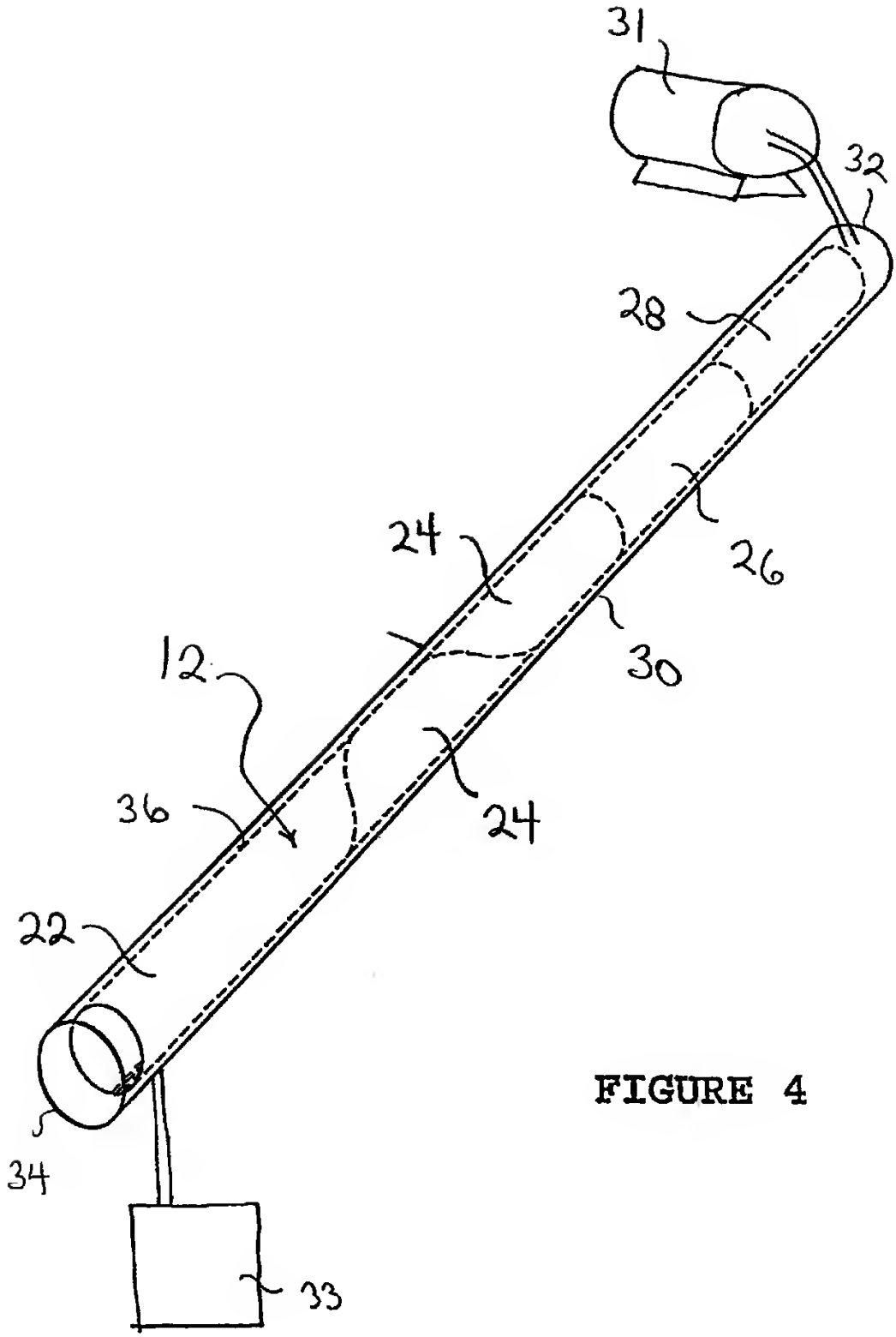


FIGURE 4

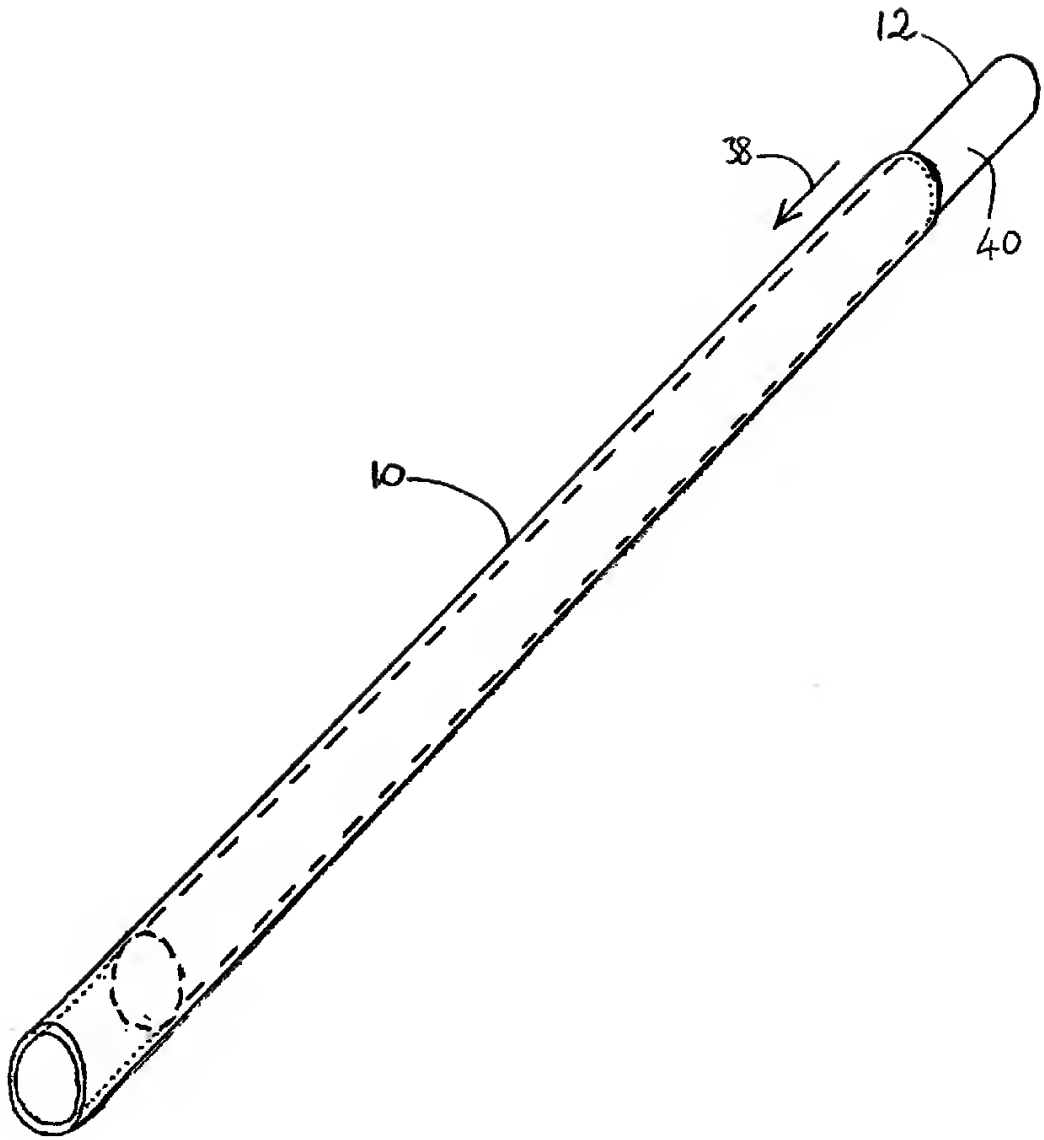
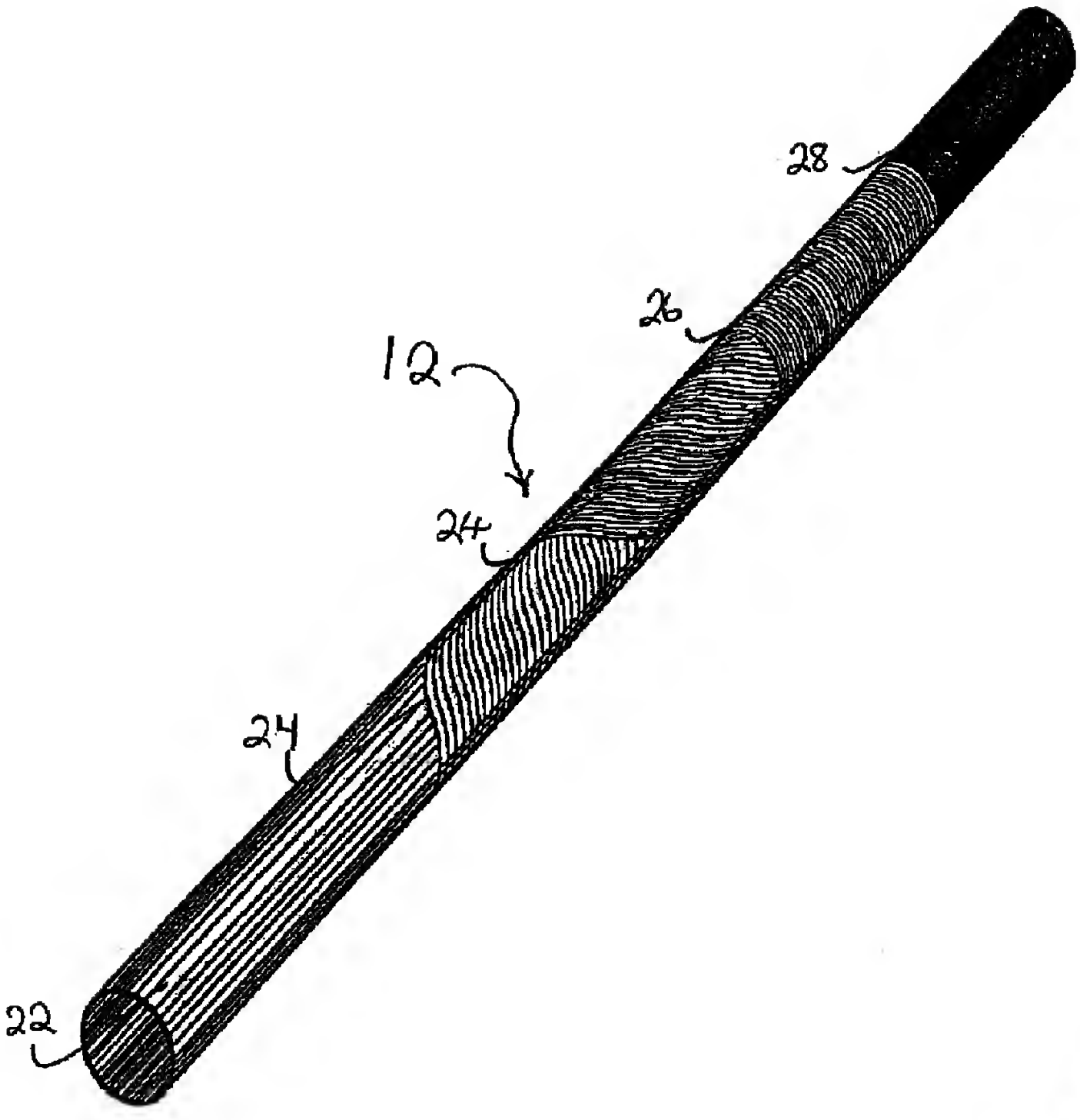


FIGURE 5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